MODULE 5
THUNDERSTORM VARIATIONS

OBJECTIVES

At the completion of this module, the student will be able to:

1) List the primary members of the thunderstorm spectrum
2) Relate each storm type to the environment in which it typically develops
3) Describe the structure and severe weather associated with each storm type

INTRODUCTION

As we have discussed earlier, the environment in which a thunderstorm forms is crucial in determining how intense and long-lived the storm will be. Recall that the two most important ingredients in the storm's environment are the amount of **instability** and the amount of **vertical wind shear**.

Researchers have developed a **thunderstorm spectrum** to describe the different storm configurations which may be found. By "configuration", we mean the severity of the storm and the length of its lifetime. There are five primary members of the thunderstorm spectrum: short-lived storms, long-lived storms, weak-updraft (non-severe) storms, strong-updraft (severe) storms, and supercell storms. Figure 5-1 below shows the relationship between instability, vertical wind shear, and the type of storm we may expect. This module will concentrate on non-supercell storms; supercells will be discussed in Module 6.

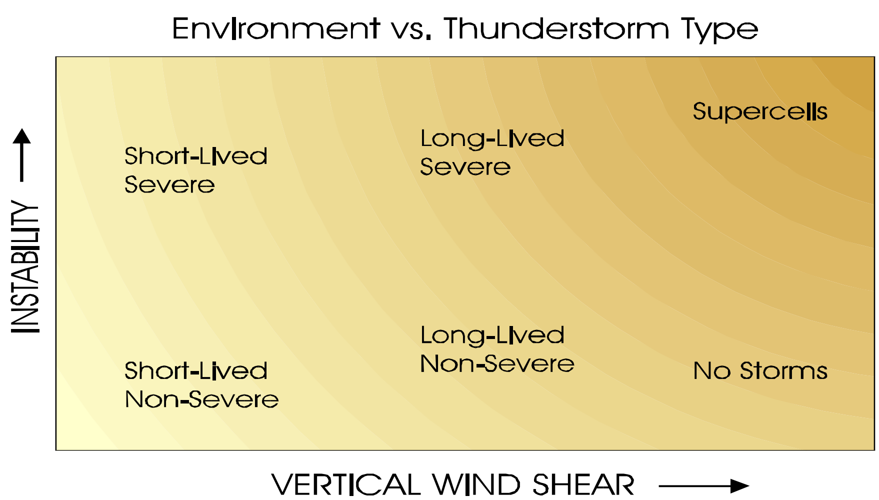

Figure 5-1: Summary of how instability and vertical wind shear affect the strength and longevity of thunderstorms.

SHORT-LIVED STORMS

Short-lived storms tend to develop in regions of **weak vertical wind shear**. They usually last about 30 minutes, and may resemble the "generic" thunderstorm described earlier in the thunderstorm life cycle module. The lack of vertical wind shear contributes to the short lifetimes of these storms. As the storm produces its precipitation and downdraft, the rain-cooled air hits the ground and spreads out in all directions. This cuts off the inflow of warm, moist air into the storm and the storm dissipates fairly quickly.

Short-lived storms are usually non-severe. Since they typically last only 20-30 minutes, they are not around long enough to become organized and produce significant severe weather. However, if the atmosphere is very unstable, then these storms may become briefly severe. Short-lived severe storms are known as **Pulse Storms**. Pulse storms may produce hail up to about 3/4 inch in diameter, microbursts, brief heavy rainfall, and weak tornadoes. These storms are rather disorganized and very difficult to forecast. Figures 5-2 and 5-3 below show an example of a short-lived storm and the life cycle of a typical short-lived storm.

Figure 5-2: Short-lived storm over Fort Worth, TX

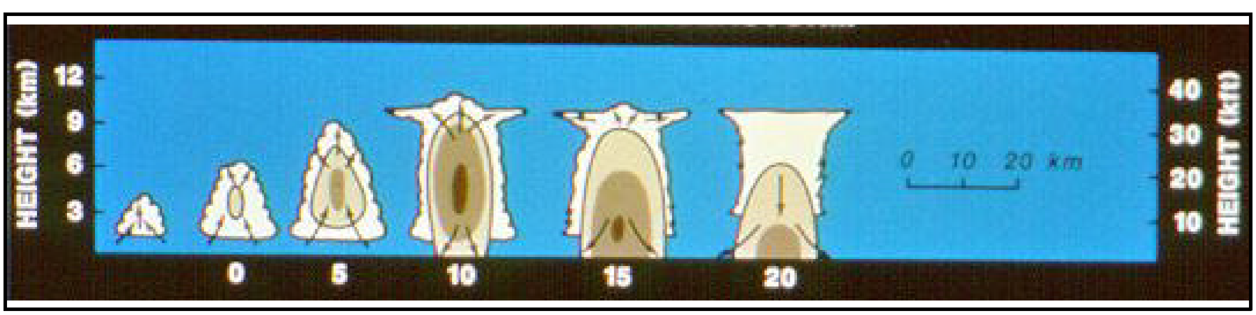

Figure 5-3: Life cycle of typical short-lived (non-severe) storm.

LONG-LIVED STORMS

Storms which develop in **stronger vertical wind shear** tend to have longer lifetimes. The increased shear has two beneficial effects on storms. First, the precipitation and downdraft produced by the storm will be blown downstream. Second, once the downdraft reaches the ground, the wind shear will keep the gust front from moving out away from the storm. This will keep a supply of unstable air flowing into the storm for a longer time. Long-lived storms tend to form in two main configurations: as **isolated clusters** of cells or as **long lines** of storms.

Cluster Storms

Cluster-type storms appear as a “clump” of short-lived storms joined together. Each cell in the cluster progresses through the thunderstorm life cycle. New updrafts tend to form on the rear (southwest) portion of the cluster, with mature cells in the center and dissipating cells on the cluster’s forward (northeast) flank. Cluster storms may last for 1-3 hours. They are capable of producing hail up to about golfball size and/or downbursts (either of which require a severe thunderstorm warning), and very heavy rainfall (which may require a flash flood warning). Weak tornadoes are possible as well (which of course mandate a tornado warning). Severe weather is most likely near the mature cells where both updraft and downdraft are found.

Spotters observing the forward portion of a cluster storm may report dark clouds but little other structure. They may report a shelf cloud associated with the gust front. Spotters following the rear portion of the storm will probably report the “hard”, cumuliform updraft towers with a rain-free cloud base underneath. If spotters have a good view of the mature cells, they will likely see a sharp transition between the rain-free base and the heavy precipitation area. Short-lived **wall clouds** may also be present. Wall clouds are local, abrupt lowerings of the rain-free base which mark the area of strongest updrafts. Figures 5-4 and 5-5 show examples of cluster storms.

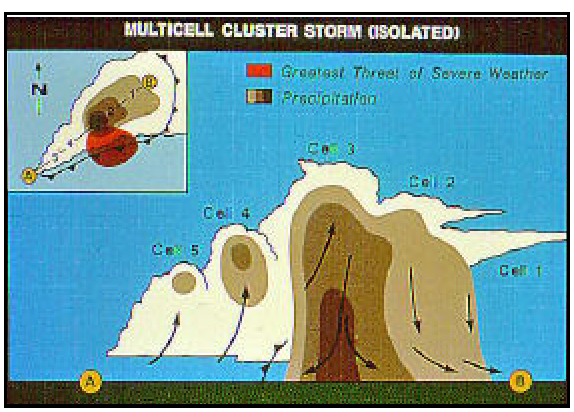

Figure 5-4: Schematic diagram of cluster-type storm. Shaded areas represent intensity of precipitation. Greatest threat of severe weather is shown in inset.

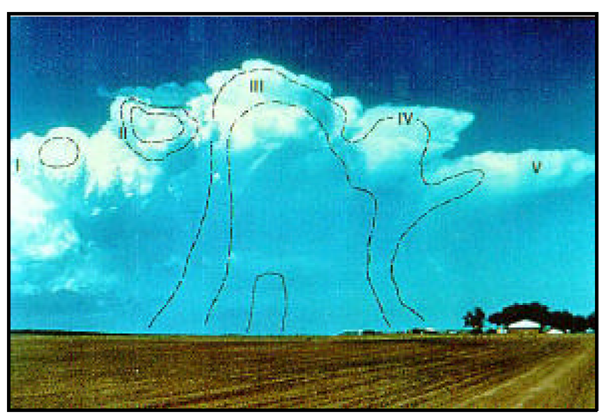

Figure 5-5: Example of cluster-type storm. View is to the west. Numbering of updraft cells is opposite of Figure 5-4.

Squall Lines

Lines of storms, known more commonly as **Squall Lines**, tend to develop along and ahead of advancing cold fronts. The lines may be solid, or gaps and breaks may be present. New updraft growth in squall lines is usually at the leading edge of the line, with the downdraft and precipitation found at the rear of the line. As with cluster storms, squall lines are capable of producing hail up to about golfball size, very heavy rainfall, and weak tornadoes. However, squall lines are very efficient downburst producers, especially if the line is oriented perpendicular to the mid-level wind flow. If these mid-level winds are strong, then they may be brought down to the surface by the downdrafts in the line. This in turn can result in a long swath of damaging winds as the line moves across.

Spotters observing a squall line will likely report a shelf cloud with growing updraft cloud towers above it if they are ahead of the line. As the line approaches, winds will shift to a direction blowing away from the line and will dramatically increase in speed. Heavy rain and possible hail will then follow. Spotters behind the line will likely observe dark clouds but little well-defined structure. Cells north of a break in the line and the southernmost cell in the line (known as the **anchor cell**) are better candidates to produce tornadoes. Spotters observing these cells may report visual features associated with supercell storms (described in the next module). Figures 5-6 and 5-7 below show examples of squall lines.

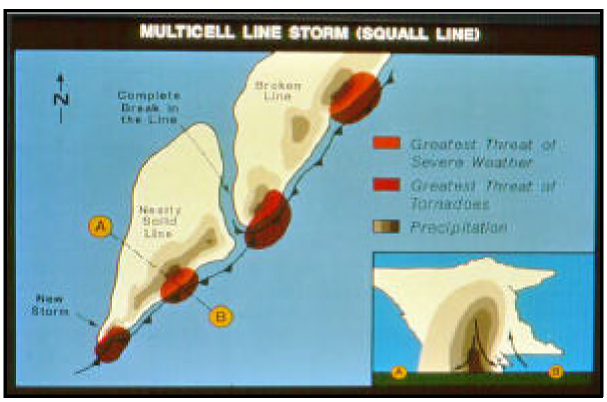

Figure 5-6: Schematic diagram of a squall line. Light shaded areas represent intensity of precipitation. Dark shaded areas indicate greatest threat of severe weather (near stronger cells) and tornadoes (north of break in the line, southernmost cell in the line).

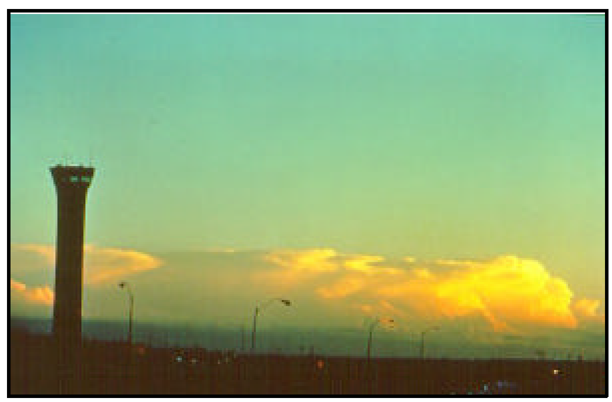

Figure 5-7: Example of a squall line, view is to the southeast from the Oklahoma City Airport. Note the newer, stronger cells to the south (right) with taller, more defined cloud tops. Older cells are evident to the north.